

5 CLAIMS

1. An improved premix secondary fuel nozzle for use in a gas turbine combustor comprising:

10 an elongated tube having a first and second opposing ends having a centerline defined therethrough and a tip region proximate said second end;

at least one first injector extending radially away from and fixed to said elongated tube and containing at least one first injector hole for injecting a fuel into said
15 combustor such that air surrounding said fuel nozzle mixes with said fuel to form a premixture;

a central core coaxial with said centerline and located radially within said elongated tube thereby forming a first passage between said central core and said
20 elongated tube, said central core extending from proximate said first opposing end to proximate said second opposing end, said central core containing a second passage extending from proximate said first opposing end to proximate said first injector for supplying fuel to said first injector, said central core also containing a third passage extending from downstream of said first injector to proximate said
25 second opposing end, each of said second and third passages coaxial with said centerline, and said central core further containing a plurality of air flow channels in fluid communication with said third passage, said air flow channels having an air flow inlet region and air flow exit region, and said first passage extending from proximate said first opposing end to upstream of said air flow inlet region of
30 said air flow channels;

a swirler fixed within said third passage for imparting a swirl to said air to cool said tip region of said fuel nozzle;

5 a second injector containing a plurality of second injector holes located proximate
said second opposing end of said elongated tube for injecting a fluid medium into
said combustor;

means for transferring said fluid medium from said first passage to said second
10 injector;

wherein all fuel is injected radially outward of and upstream of said swirler so as
to not directly initiate a pilot flame.

15 2. The improved premix secondary fuel nozzle of Claim 1 wherein said first injector
comprises an annular manifold circumferentially disposed about said elongated tube and
affixed to a plurality of support members, said support members affixed to said elongated
tube such that said annular manifold is in fluid communication with said second passage,
said annular manifold having a plurality of first injector holes situated about its periphery
20 and oriented to inject said fuel in a downstream direction, at least one of said first injector
holes being circumferentially offset from said support members.

3. The improved premix secondary fuel nozzle of Claim 2 wherein at least one of said
first injector holes of said annular manifold is angled relative to the downstream
25 direction.

4. The improved premix secondary fuel nozzle of Claim 1 wherein said means for
transferring said medium includes a plurality of transfer tubes having opposing ends, said
transfer tubes surrounding said third passage and extending from upstream of said first
30 injector to an annular plenum proximate said second injector.

5. The improved premix secondary fuel nozzle of Claim 4 wherein said fluid medium can
be either fuel or air, depending on combustor mode of operation.

- 5 6. The improved premix secondary fuel nozzle of Claim 4 wherein seven of said transfer tubes surrounds seven of said airflow channels.
7. The improved premix secondary fuel nozzle of Claim 1 wherein said first injector comprises a plurality of radially extending tubes, each of said tubes having at least one
10 first hole, said hole injecting said fuel in the downstream direction, said plurality of radially extending tubes are in fluid communication with said second passage.
8. The improved premix secondary fuel nozzle of Claim 7 wherein at least one of said first injector holes is angled in the circumferential direction.
- 15 9. The improved premix secondary fuel nozzle of Claim 1 wherein said means for transferring said fluid medium comprises a generally annular passageway extending from upstream of said first injector to said second injector.
- 20 10. An improved dual stage, dual mode gas turbine combustor comprising:
- a primary combustion chamber;
- at least one primary fuel nozzle to deliver fuel to said primary combustion
25 chamber;
- a secondary combustion chamber adjacent to and downstream of said primary combustion chamber wherein said primary and secondary combustion chambers are separated by a venturi; and
- 30 a secondary fuel nozzle positioned to inject fuel towards said secondary combustion chamber and surrounded by a plurality of said primary fuel nozzles wherein said secondary fuel nozzle comprises:

5 an elongated tube having a first and second opposing ends having a centerline defined therethrough and a tip region proximate said second end;

10 at least one first injector extending radially away from and fixed to said elongated tube and containing at least one first injector hole for injecting a fuel into said combustor such that air surrounding said fuel nozzle mixes with said fuel to form a premixture;

15 a central core coaxial with said centerline and located radially within said elongated tube thereby forming a first passage between said central core and said elongated tube, said central core extending from proximate said first opposing end to proximate said second opposing end, said central core containing a second passage extending from proximate said first opposing end to proximate said first injector for supplying fuel to said first injector, said central core also containing a third passage extending from downstream of said first injector to proximate said second opposing end, each of said second and third passages coaxial with said centerline, and said central core further containing a plurality of air flow channels in fluid communication with said third passage, said air flow channels having an air flow inlet region and air flow exit region, and said first passage extending from proximate said first opposing end to upstream of said air flow inlet region of said air flow channels;

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30 a swirler fixed within said third passage for imparting a swirl to said air to cool said tip region of said fuel nozzle;

a second injector containing a plurality of second injector holes located proximate said second opposing end of said elongated tube for injecting a fluid medium into said combustor;

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5 means for transferring said fluid medium from said first passage to said second injector;

wherein all fuel is injected radially outward of and upstream of said swirler so as to not directly initiate a pilot flame.

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11. The improved gas turbine combustor of Claim 10 wherein said first injector comprises an annular manifold circumferentially disposed about said elongated tube and affixed to a plurality of support members, said support members affixed to said elongated tube such that said annular manifold is in fluid communication with said second passage, said annular manifold having a plurality of first injector holes situated about its periphery and oriented to inject said fuel in a downstream direction, at least one of said first injector holes being circumferentially offset from said support members.

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12. The improved gas turbine combustor of Claim 11 wherein at least one of said first injector holes of said annular manifold is angled relative to the downstream direction.

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13. The improved gas turbine combustor of Claim 10 wherein said means for transferring said medium includes a plurality of transfer tubes having opposing ends, said transfer tubes surrounding said third passage and extending from upstream of said first injector to an annular plenum proximate said second injector.

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14. The improved gas turbine combustor of Claim 13 wherein said fluid medium can be either fuel or air, depending on combustor mode of operation.

15. The improved gas turbine combustor of Claim 13 wherein seven of said transfer tubes surrounds seven of said airflow channels.

16. The improved gas turbine combustor of Claim 10 wherein said first injector comprises a plurality of radially extending tubes, each of said tubes having at least one

5 first hole, said hole injecting said fuel in the downstream direction, said plurality of
radially extending tubes are in fluid communication with said second passage.

17. The improved premix secondary fuel nozzle of Claim 16 wherein at least one of said
first injector holes is angled in the circumferential direction.

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18. The improved premix secondary fuel nozzle of Claim 10 wherein said means for
transferring said fluid medium comprises a generally annular passageway extending from
upstream of said first injector to said second injector.

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19. An improved premix secondary fuel nozzle for use in a gas turbine combustor
comprising:

an elongated tube having a first and second opposing ends having a centerline
defined therethrough and a tip region proximate said second end;

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at least one first injector extending radially away from and fixed to said elongated
tube and containing at least one first injector hole for injecting a fuel into said
combustor such that air surrounding said fuel nozzle mixes with said fuel to form
a premixture;

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a central core coaxial with said centerline and located radially within said
elongated tube thereby forming a first passage between said central core and said
elongated tube, said central core extending from proximate said first opposing end
to proximate said second opposing end, said central core containing a second
passage extending from proximate said first opposing end to proximate said first
injector for supplying fuel to said first injector, said central core also containing a
third passage extending from downstream of said first injector to proximate said
second opposing end, each of said second and third passages coaxial with said
centerline, and said central core further containing a plurality of air flow channels
in fluid communication with said third passage, said air flow channels having an

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5 air flow inlet region and air flow exit region, and said first passage extending from proximate said first opposing end to upstream of said air flow inlet region of said air flow channels;

10 a tip plate fixed to said central core proximate said tip region, said tip plate having a first surface, a second surface, a plate thickness therebetween, and a plurality of cooling holes extending from said first surface to said second surface such that said cooling holes have a hole length L ;

15 a second injector containing a plurality of second injector holes located proximate said second opposing end of said elongated tube for injecting a fluid medium into said combustor;

20 means for transferring said fluid medium from said first passage to said second injector;

 wherein all fuel is injected radially outward of and upstream of said tip plate so as to not directly initiate a pilot flame.

25 20. The improved premix secondary fuel nozzle of Claim 19 wherein said first injector comprises an annular manifold circumferentially disposed about said elongated tube and affixed to a plurality of support members, said support members affixed to said elongated tube such that said annular manifold is in fluid communication with said second passage, said annular manifold having a plurality of first injector holes situated about its periphery and oriented to inject said fuel in a downstream direction, at least one of said first injector
30 holes being circumferentially offset from said support members.

 21. The improved premix secondary fuel nozzle of Claim 20 wherein at least one of said first injector holes of said annular manifold is angled relative to the downstream direction.

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- 5 22. The improved premix secondary fuel nozzle of Claim 19 wherein said means for transferring said medium includes a plurality of transfer tubes having opposing ends, said transfer tubes surrounding said third passage and extending from upstream of said first injector to an annular plenum proximate said second injector.
- 10 23. The improved premix secondary fuel nozzle of Claim 22 wherein said fluid medium can be either fuel or air, depending on combustor mode of operation.
24. The improved premix secondary fuel nozzle of Claim 22 wherein seven of said transfer tubes surrounds seven of said airflow channels.
- 15 25. The improved premix secondary fuel nozzle of Claim 19 wherein said first injector comprises a plurality of radially extending tubes, each of said tubes having at least one first hole, said hole injecting said fuel in the downstream direction, said plurality of radially extending tubes are in fluid communication with said second passage.
- 20 26. The improved premix secondary fuel nozzle of Claim 25 wherein at least one of said first injector holes is angled in the circumferential direction.
27. The improved premix secondary fuel nozzle of Claim 19 wherein said means for transferring said fluid medium comprises a generally annular passageway extending from upstream of said first injector to said second injector.
- 25 28. The improved premix secondary fuel nozzle of Claim 19 wherein said plate thickness is at least 0.125 inches.
- 30 29. The improved premix secondary fuel nozzle of Claim 28 wherein said cooling holes of said tip plate are generally perpendicular to said second surface such that said hole length L equals said plate thickness.

5 30. The improved premix secondary fuel nozzle of Claim 29 wherein said cooling holes have a diameter D ranging from 0.020 inches to 0.070 inches.

31. The improved premix secondary fuel nozzle of Claim 19 wherein said cooling holes of said tip plate are oriented at an angle α with respect to said second surface.

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32. The improved premix secondary fuel nozzle of Claim 31 wherein said angle α ranges from 25 degrees to 45 degrees.

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33. The improved premix secondary fuel nozzle of Claim 32 wherein said cooling holes have a diameter D ranging from 0.020 inches to 0.070 inches.

34. The improved premix secondary fuel nozzle of Claim 33 wherein said hole length L of said cooling holes is greater than said plate thickness.

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